Next Generation Space Internet: Standards and Implementation

http://www.aist-ngsi.org

NASA Earth Science Technology Conference
June 26, 2003

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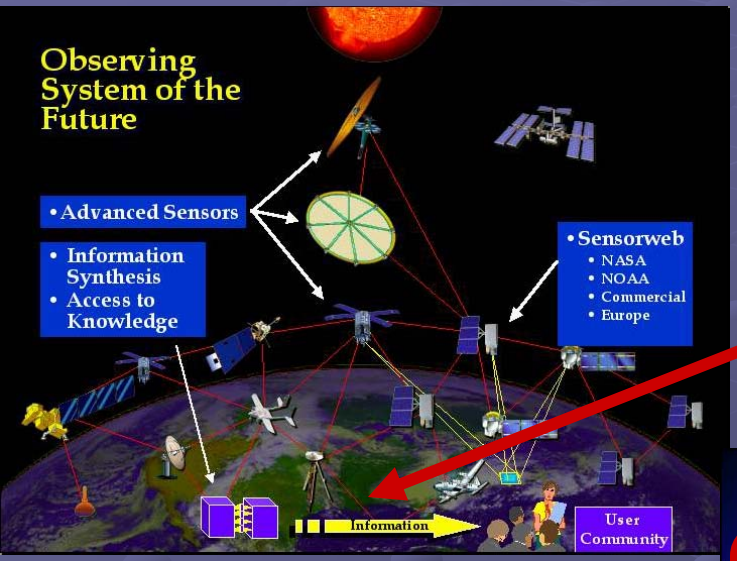
AGENDA

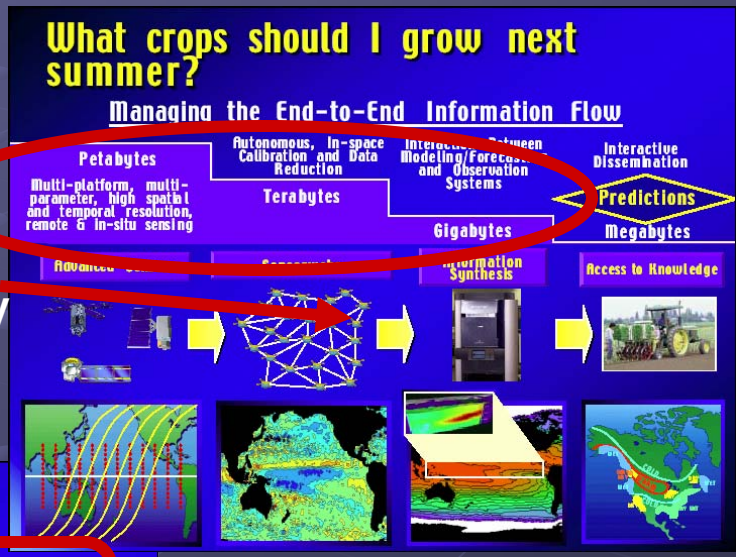
- Future mission requirements & assumptions
- NGSI services
- Standardization
- Implementation

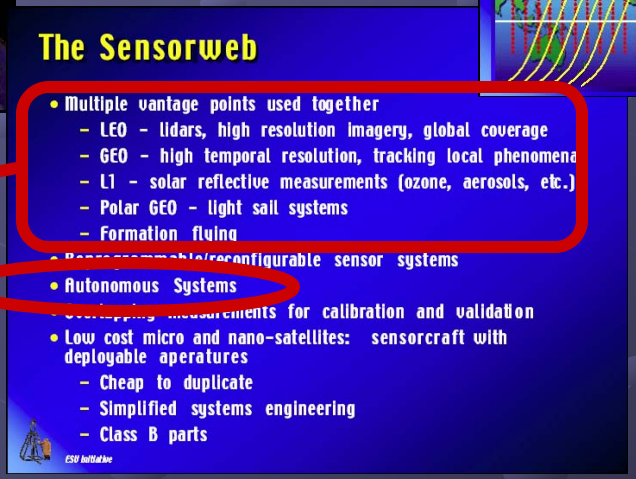
Future Mission Requirements



Large Data Sets

Internet Connectivity





Networks

Autonomous Spacecraft

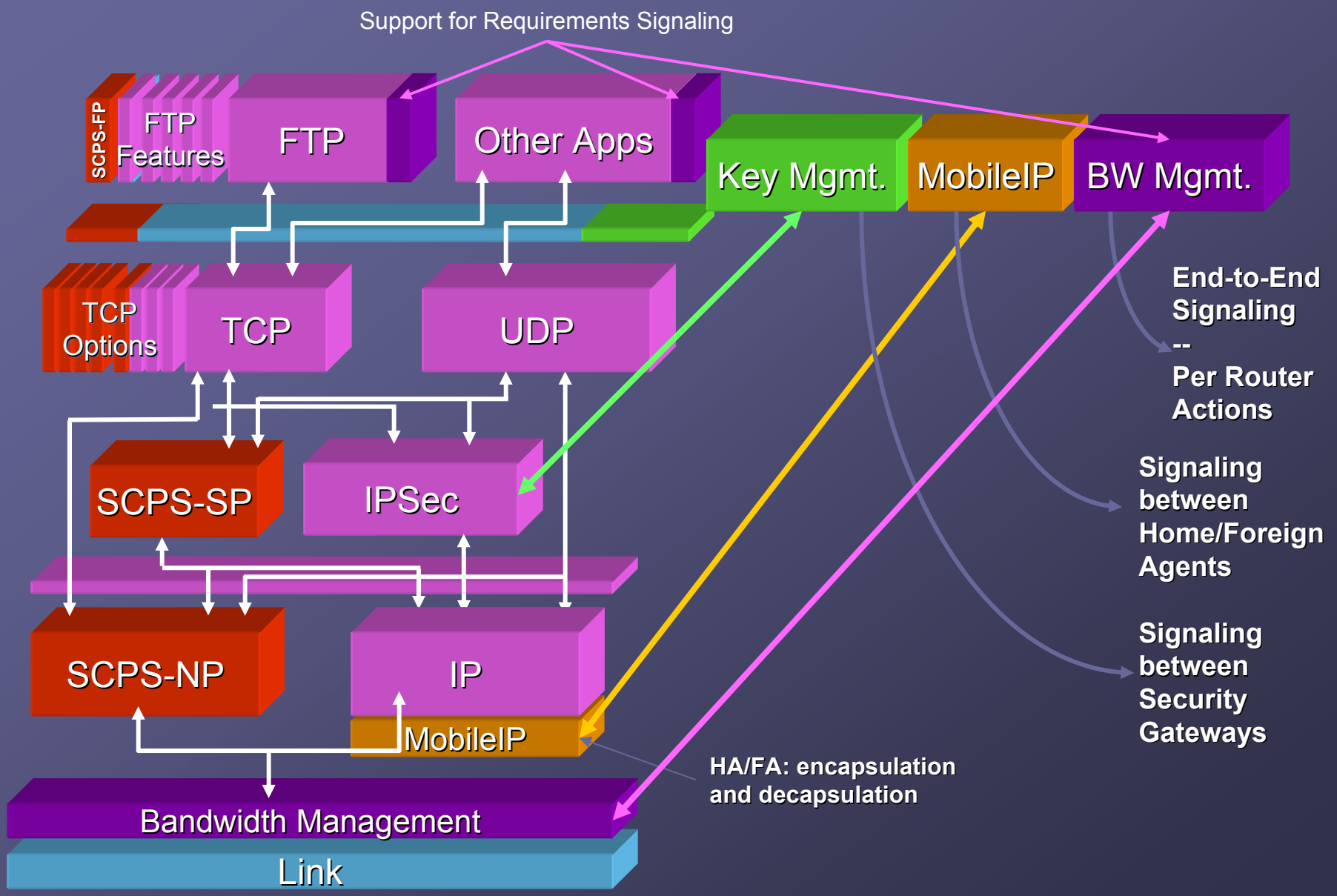
Challenges

- Connectivity
  - Point of attachment between orbiting sensor net and the Internet changes
- Security
  - Your spacecraft is at 66.170.238.241? I always wanted my own spacecraft…
- Efficiency
  - Large data sets require efficiency, especially across the space-to-ground link

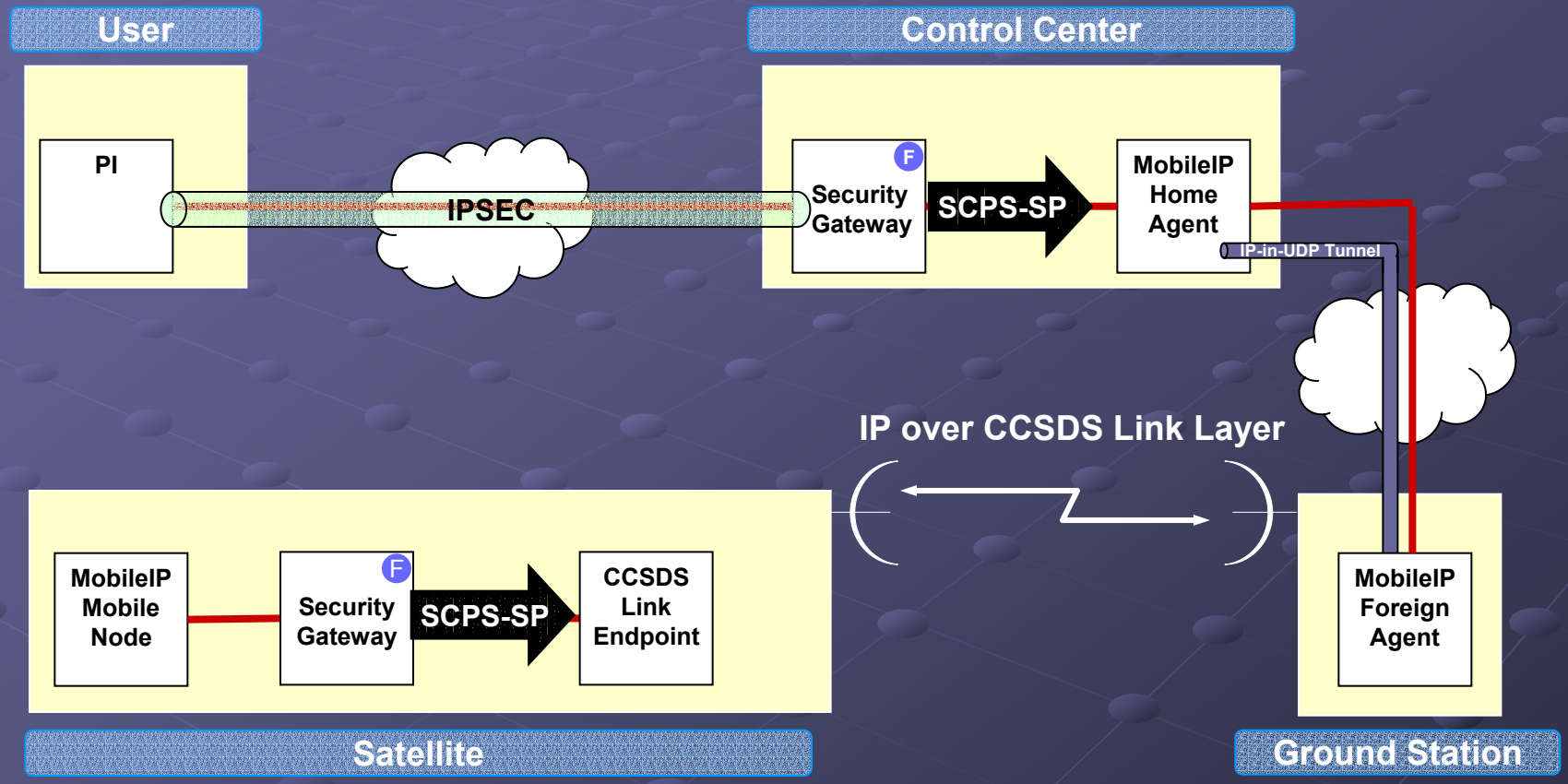
Approach

- Standardized protocols / extensions allowing multiple vendor implementations:
  - Security gateways
  - Advanced IP Mobility
  - Resource Reservation
- Proof-of-concept implementation

NGSI Protocol Extensions



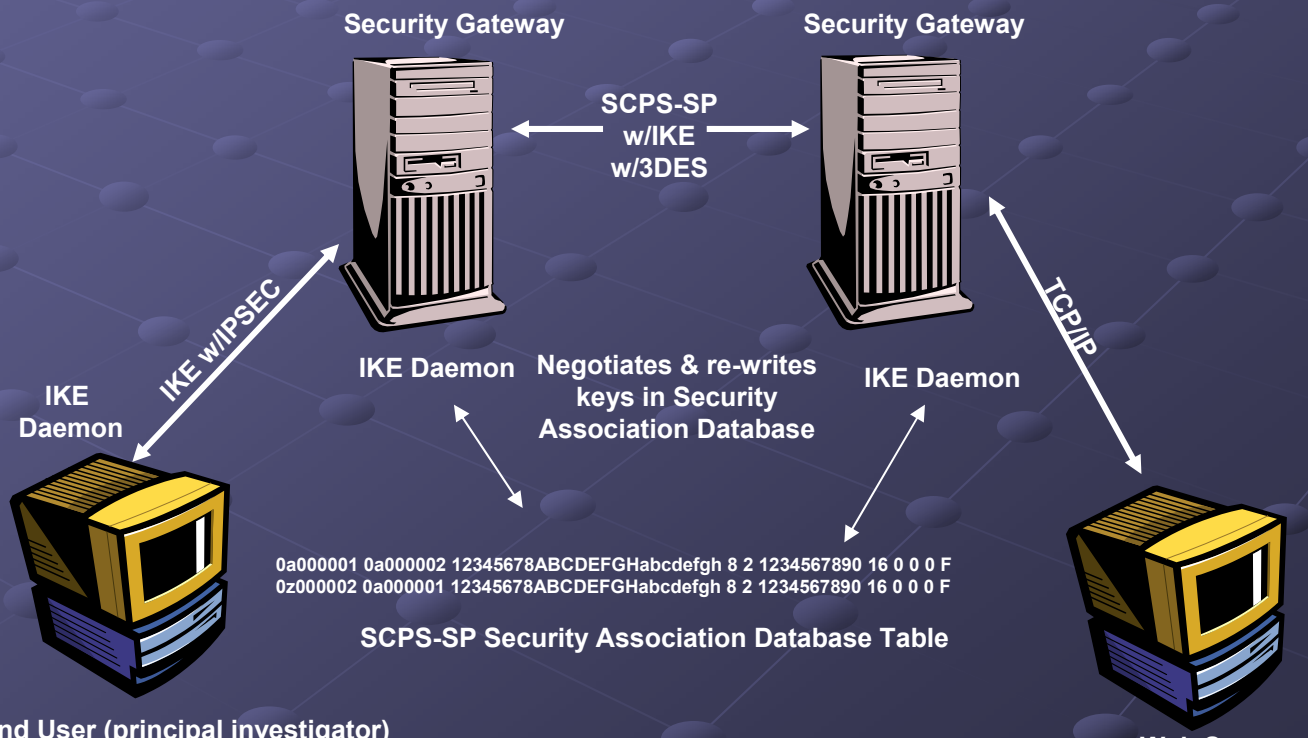
NGSI Architecture



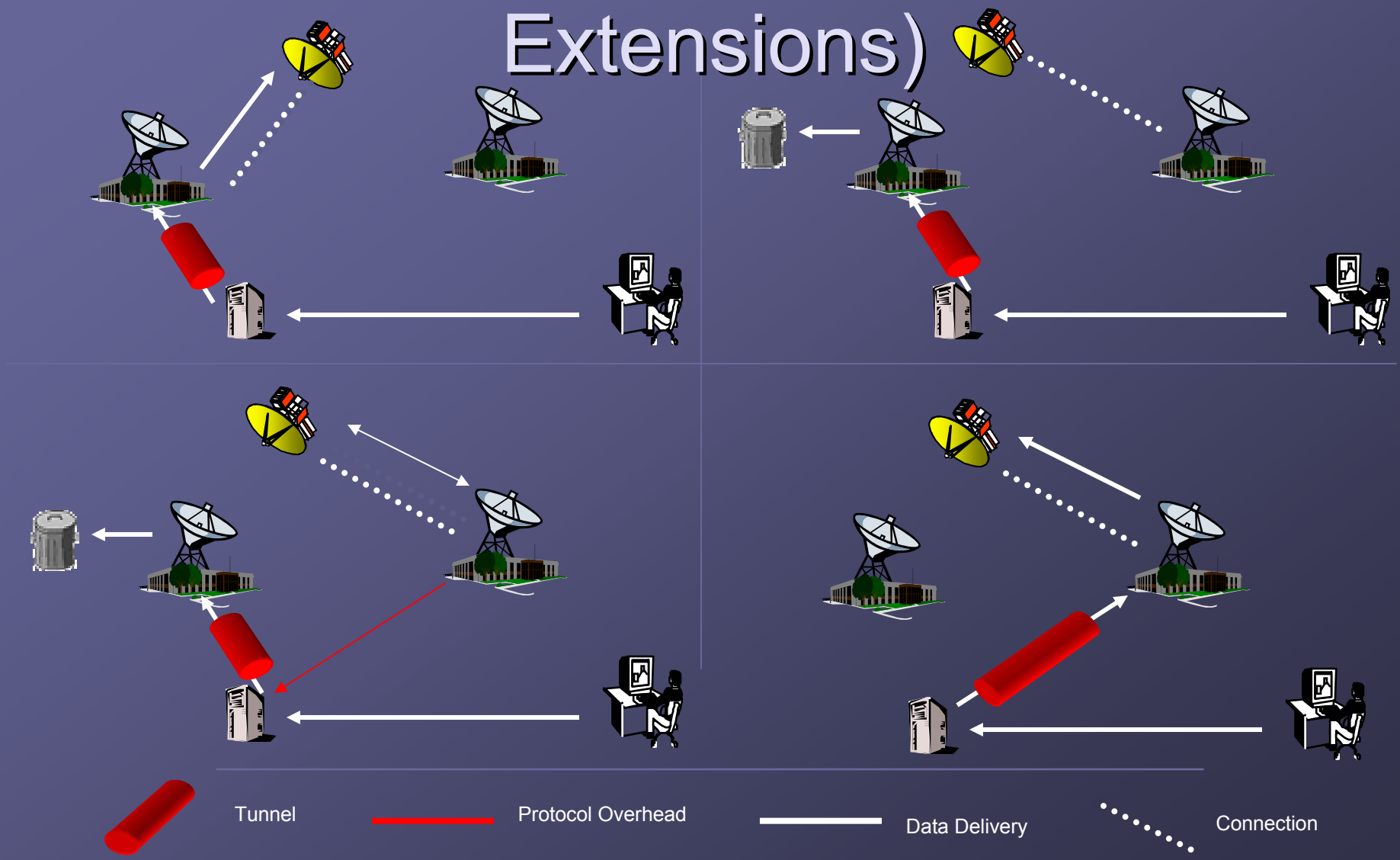
Intserv (RSVP) prevents congestion-based loss
MobileIP allows Internet-based users to contact spacecraft
Security gateways translate between IPSEC and SCPS-SP

IPSEC / SCPS-SP Security Gateways

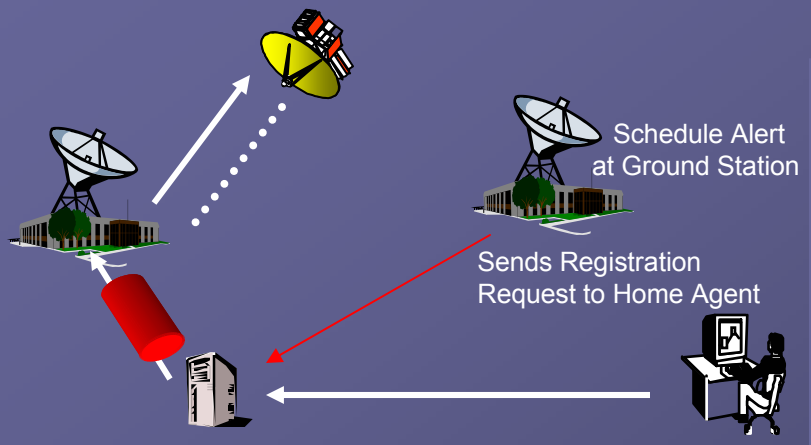
- SCPS-SP has lower overhead than IPSEC
- Trusted gateways allow logging, monitoring, policing, PEPs
- *Standardized IKE options for efficient key exchange*

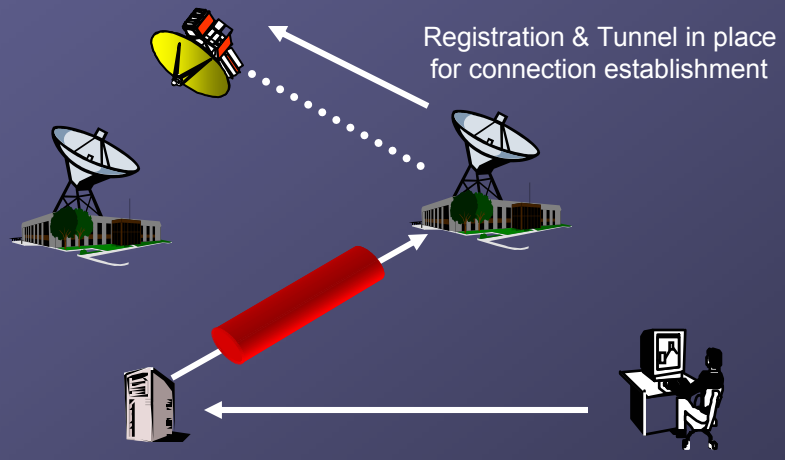


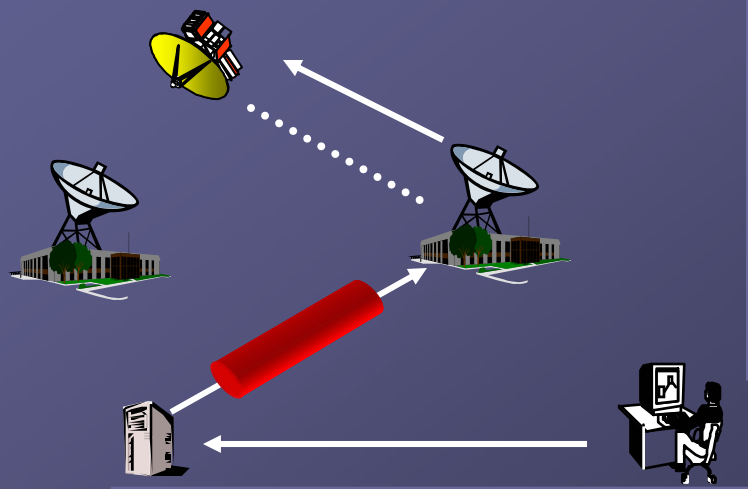
Standard MobileIP (No NGSI Extensions)



MobileIP with NGSI Extensions



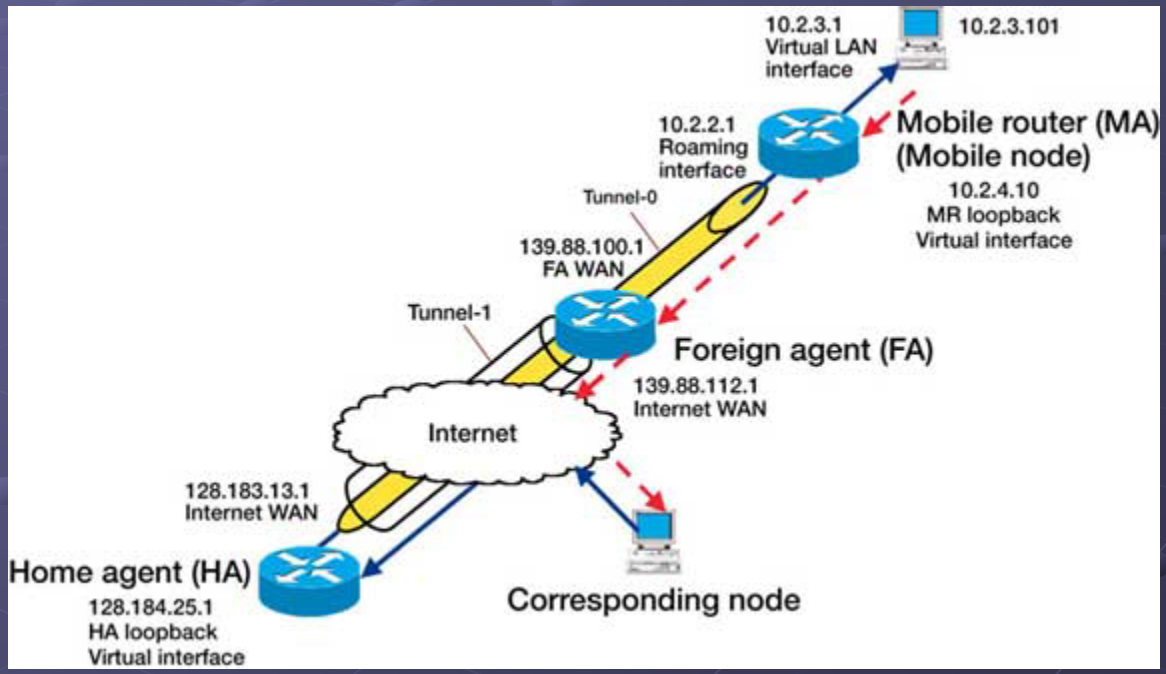




- *Standardized MobileIP extensions for scheduled operations*
  - Mobile router uses IP-in-IP tunnel and MobileIP signaling across the space link

Mobile Router

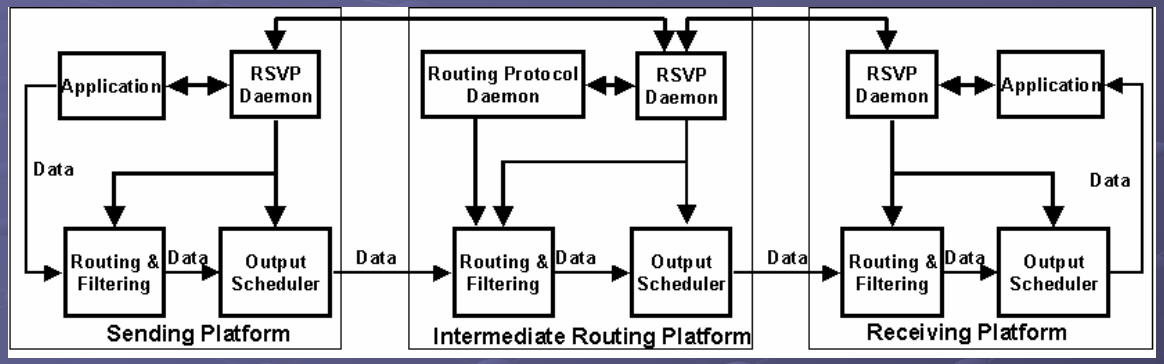
- Really designed for 'one-hop' mobile
  - Each mobile router supports a *fixed* mobile subnet
- Carries IP tunnel across the mobile channel



NGSI and Cisco Mobile Router Approaches

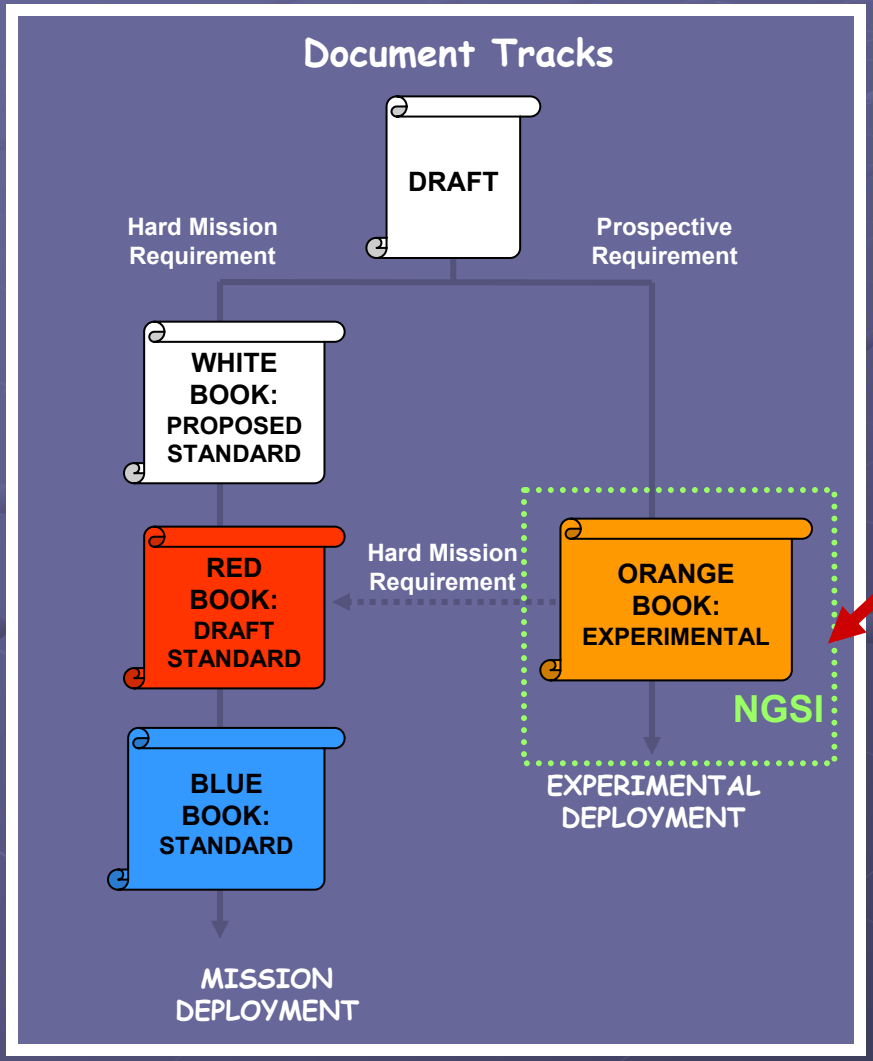
Feature	Cisco Mobile Router	NGSI
Mobile – FA Signaling (Across the space-to-ground link)	Yes – Router Solicitation / Advertisement / Mobile Registration	No – MobileIP tunnel configured ahead of time
Per-packet overhead	IP-in-IP encapsulation (20 bytes)	None
Operation in multi-hop constellation environment	Difficult for dynamic and multi-hop constellations	Yes

RSVP



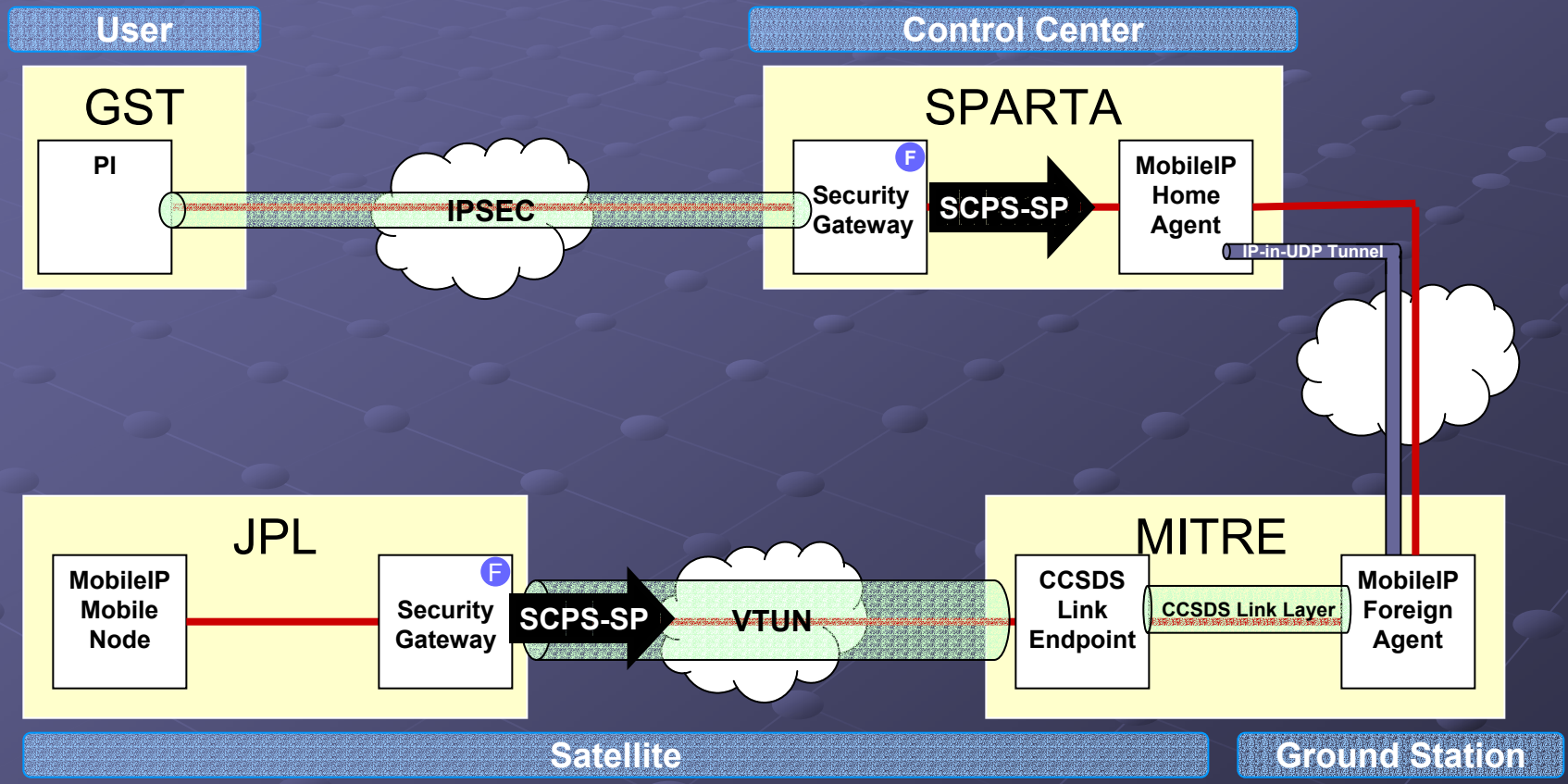
- Protects data from congestion-based loss, provides some class of service (CoS)
- Applications signal data requirements to the network
- Network responds (yes/no)
  - If yes, network provisions the path ➔ prevents congestion loss
- *Standardized RSVP extensions for protocol translating gateways*

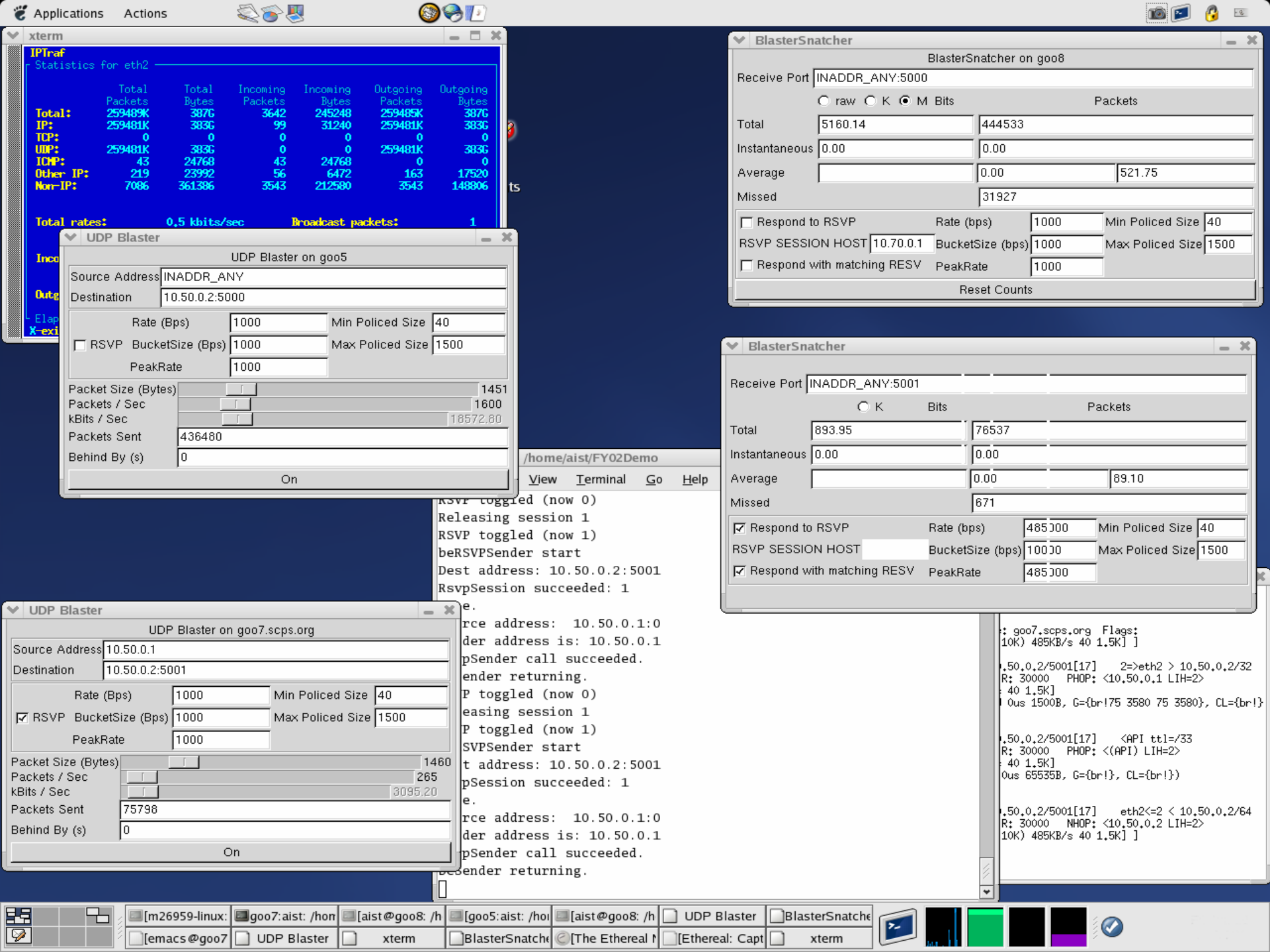
Standardization



- Few missions currently requesting IP services
- Standardizing NGSI services in CCSDS 'experimental' track
  - Feedback from space agencies and interested parties
  - Can be quickly converted to standards track when appropriate

Prototype Implementation




Applications
Actions
xterm
IPTraf
Statistics for eth2
Total Packets
Total Bytes
Incoming Packets
Incoming Bytes
Outgoing Packets
Outgoing Bytes
Total: 259489K 387G 3642 245248 259485K 387G
IP: 259481K 383G 99 31240 259481K 383G
TCP: 0 0 0 0 0 0
UDP: 259481K 383G 0 0 259481K 383G
ICMP: 43 24768 43 24768 0 0
Other IP: 219 23992 56 6472 163 17520
Non-IP: 7086 361386 3543 212580 3543 148806
Total rates: 0,5 kbits/sec
Broadcast packets: 1
UDP Blaster
UDP Blaster on goo5
Source Address INADDR_ANY
Destination 10.50.0.2:5000
Rate (Bps) 1000
Min Policed Size 40
RSVP
BucketSize (Bps) 1000
Max Policed Size 1500
PeakRate 1000
Packet Size (Bytes) 1451
Packets / Sec 1600
kBits / Sec 18572.80
Packets Sent 436480
Behind By (s) 0
On
BlasterSnatcher
BlasterSnatcher on goo8
Receive Port INADDR_ANY:5000
raw K M Bits
Packets
Total 5160.14 444533
Instantaneous 0.00 0.00
Average 0.00 521.75
Missed 31927
Respond to RSVP
Rate (bps) 1000
Min Policed Size 40
RSVP SESSION HOST 10.70.0.1
BucketSize (bps) 1000
Max Policed Size 1500
Respond with matching RESV
PeakRate 1000
Reset Counts
BlasterSnatcher
Receive Port INADDR_ANY:5001
K
Bits
Packets
Total 893.95 76537
Instantaneous 0.00 0.00
Average 0.00 89.10
Missed 671
Respond to RSVP
Rate (bps) 485000
Min Policed Size 40
RSVP SESSION HOST
BucketSize (bps) 100000
Max Policed Size 1500
Respond with matching RESV
PeakRate 485000
/home/aist/FY02Demo
View Terminal Go Help
RSVP toggled (now 0)
Releasing session 1
RSVP toggled (now 1)
beRSVPSender start
Dest address: 10.50.0.2:5001
RsvpSession succeeded: 1
e.
rce address: 10.50.0.1:0
der address is: 10.50.0.1
pSender call succeeded.
ender returning.
P toggled (now 0)
easing session 1
P toggled (now 1)
SVPSender start
t address: 10.50.0.2:5001
pSession succeeded: 1
e.
rce address: 10.50.0.1:0
der address is: 10.50.0.1
pSender call succeeded.
ender returning.
: goo7.scps.org Flags:
10K) 485KB/s 40 1.5K]]
.50.0.2/5001[17] 2=>eth2 > 10.50.0.2/32
R: 30000 PHOP: <10.50.0.1 LIH=2>
40 1.5K]
0us 1500B, G={br!75 3580 75 3580}, CL={br!}
.50.0.2/5001[17] <API ttl=/33
R: 30000 PHOP: <(API) LIH=2>
40 1.5K]
0us 65535B, G={br!}, CL={br!})
.50.0.2/5001[17] eth2<=2 < 10.50.0.2/64
R: 30000 NHOP: <10.50.0.2 LIH=2>
10K) 485KB/s 40 1.5K]]
UDP Blaster
UDP Blaster on goo7.scps.org
Source Address 10.50.0.1
Destination 10.50.0.2:5001
Rate (Bps) 1000
Min Policed Size 40
RSVP
BucketSize (Bps) 1000
Max Policed Size 1500
PeakRate 1000
Packet Size (Bytes) 1460
Packets / Sec 265
kBits / Sec 3095.20
Packets Sent 75798
Behind By (s) 0
On
[m26959-linux:
goo7:aist: /hon
[aist@goo8: /h
[goo5:aist: /ho
[aist@goo8: /h
UDP Blaster
BlasterSnatche
[emacs@goo7
UDP Blaster
xterm
BlasterSnatche
[The Ethereal N
[Ethereal: Capt
xterm

Standards-Based Approach to IP in Space

- Runs over any link layer(s) that support IP; tested with CCSDS telemetry / telecommand
- Open international standards:
  - Can be implemented by any vendor
  - Allow international cross-support for missions
- SCPS + NGSI Maximize Data Return
  - High-efficiency network, security, and transport
    - End-to-end or via gateways
  - Low-overhead mobility support for spacecraft
  - Resource reservation to prevent congestion loss

Questions